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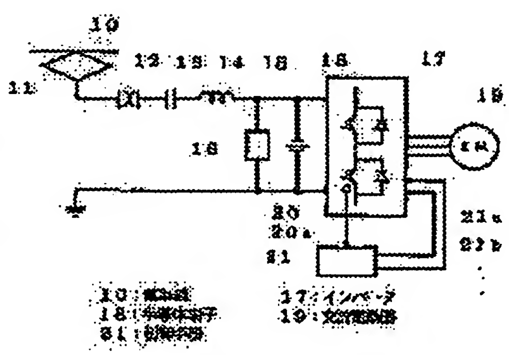
(54) CONTROLLING DEVICE FOR ELECTRIC CAR

(57)Abstract:
PROBLEM TO BE SOLVED: To miniaturize a cooler.
SOLUTION: In a controlling device for electric cars where the DC power of an electric train line 10 is converted to AC by an inverter 17 which is composed of a semiconductor element 18 being switched at a specific switching frequency for driving an AC electric motor 19. Regenerative power is sent to the electric train line 10 via the AC electric motor 19 when brakes are applied. A controlling means 21 is provided for reducing the switching frequency of a semiconductor element 18 when the temperature change rate of the semiconductor element 18 to time exceeds a setting value.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the control unit for electric rolling stock which controls the AC motor for actuation by the inverter.
[0002]
[Description of the Prior Art] Drawing 5 is the block diagram of the conventional control unit for electric rolling stock. In drawing 5 , direct current power is supplied to an inverter 4 through a pantograph 2 and a breaker 3 from an electric car track 1. An inverter 4 controls a semiconductor device 5 by the predetermined switching frequency, changes it into alternating current power, and supplies predetermined power to AC motor 6 for actuation according to driving force required for actuation of electric rolling stock. AC motor 6 drives by this and electric rolling stock will be in a power running condition. Moreover, the alternating current power which AC motor 6 generated at the time of a brake is changed into direct current power by the switching control of an inverter 4, and is sent out to an electric car track 1 through a breaker 3 as regeneration power. Another electric rolling stock which has received supply of power from the same electric car track 1 consumes the sent-out direct current power. And a comparator 9 compares temperature detecting-signal 7a of the semiconductor device 5 detected by the temperature sensor 7, and temperature setpoint signal 8a corresponding to the protection temperature of the semiconductor device 5 set up with the temperature setting-out means 8. Here, when temperature detecting-signal 7a exceeds temperature setpoint signal 8a, the switching control of a semiconductor device 5 is stopped.
[0003]
[Problem(s) to be Solved by the Invention] Since the conventional control unit for electric rolling stock is constituted as mentioned above, in the right of way in which the ground and underground are intermingled, the refrigeration capacity of a semiconductor device 5 is set up to the highest ambient temperature of the ambient temperature in the ground in a summer as a design condition. For this reason, when ambient temperature runs the low underground right of way compared with the ground, remaining power occurs in the refrigeration capacity of a semiconductor device 5. Thus, since the refrigeration capacity of a semiconductor device 5 was set up to the highest ambient temperature in the ground in a summer in the right of way in which the ground and underground are intermingled, when running underground, even if remaining power was in refrigeration capacity, there was a trouble that it was difficult to attain the miniaturization of a condensator. Furthermore, since a halt of switching control was performed when a semiconductor device 5 carries out a temperature rise rapidly by failure of a condensator, and the protection temperature of a semiconductor device 5 is exceeded and it was necessary to give remaining power to the refrigeration capacity of a condensator, there was a trouble that it was difficult to attain a miniaturization.
[0004] This invention was made in order to cancel the above troubles, and it aims at offering the control unit for electric rolling stock which can attain the miniaturization of a condensator by computing the rate of a temperature change of a semiconductor device, and controlling the switching frequency of an inverter. Furthermore, when the rate of a temperature change becomes beyond a failure decision value, it aims at offering the control unit for electric rolling stock which can attain the miniaturization of a condensator by stopping an inverter.
[0005]

[Means for Solving the Problem] The control device for electric rolling stock concerning this invention changes the direct current power of an electric car track into alternating current power with the inverter which consisted of semiconductor devices switched on a predetermined switching frequency, drives an AC motor, and in the control device for electric rolling stock which sent out regeneration power to the electric car track through the AC motor at the time of a brake, when the rate of a temperature change to the time amount of a semiconductor device becomes beyond the set point, it is equipped with the control means to which the switching frequency of a semiconductor device is reduced. Moreover, when the rate of a temperature change to the time amount of a semiconductor device is below the set point, it has the control means to which the switching frequency of a semiconductor device is made to increase. Furthermore, when it becomes beyond the failure decision value with which the rate of a temperature change to the time amount of a semiconductor device is recognized to be failure of the condensator of a semiconductor device, it has the control means which stops an inverter.

[0006]

[Embodiment of the Invention] Gestalt 1. drawing 1 of operation is the block diagram of the gestalt 1 of operation. In drawing 1 , 10 is an electric car track and direct current power is supplied. As for a pantograph and 12, a smoothing capacitor and 16 are overvoltage protection means, and a breaker and 13 protect [11 / a contactor and 14 / a smooth reactor and 15] the overvoltage of a circuit. 17 is the inverter of an adjustable electrical potential difference and a variable frequency form, and consists of semiconductor devices 18, such as power metal-oxide semiconductor field effect transistor of good control, and IGBT. In addition, the semiconductor device 18 is cooled so that it may become below predetermined temperature with a condensator (not shown). 19 is the AC motor with which alternating current power is supplied from an inverter 17, and drives electric rolling stock. 20 is a temperature sensor, detects the temperature of a semiconductor device 18 and outputs temperature detecting-signal 20a. 21 is the control means as which temperature detecting-signal 20a is inputted, and when the rate of a temperature change is computed and the rate of a temperature change exceeds the set point, it takes out control signal 21a to which a switching frequency is reduced.

[0007] Next, actuation is explained. Drawing 2 is a flow chart explaining actuation of drawing 1 . In drawing 1 and drawing 2 , when electric rolling stock drives by the usual power running, i.e., the driving force of AC motor 19, the alternating current power changed with the inverter 17 where a breaker 12 and a contactor 13 are thrown in is supplied to AC motor 19. Moreover, the alternating current power generated with AC motor 19 at the time of a brake is changed into direct current power with an inverter 17, and regeneration operation is performed by sending out from a pantograph 11 to an electric car track 10 as regeneration power. And although another electric rolling stock which has received supply of power from the electric car track 10 consumes the sent-out direct current power, since the electrical potential difference of an electric car track 10 will rise if there is little power consumption, the overvoltage protection means 16 operates and protects it. Here, in the right of way in which the ground and underground are intermingled, the difference of ambient temperature is large as an environmental condition. For this reason, the highest ambient temperature of a terrestrial summer is adopted as cooling conditions for a semiconductor device 18.

[0008] Therefore, since remaining power is in refrigeration capacity when running the underground right of way, an inverter 17 is operated with the highest switching frequency. Although the noise can incidentally be reduced by raising a switching frequency more than audio frequency, since the power loss of a semiconductor device 18 increases, as shown in drawing 2 in consideration of a priority, the optimal switching frequency is determined (step S1). A temperature sensor 20 detects temperature of a semiconductor device 18 (step S2), and temperature detecting-signal 20a is outputted. The control means 21 as which temperature detecting-signal 20a was inputted is t0. Rate of temperature change (T-T0)/(t-t0) to time amount is computed from the temperature C of T degrees of temperature T0 **C of the semiconductor device 18 in front of a second, and the semiconductor device 18 at present [t]. And when it is not over the set point of the rate of a temperature change set as the value recognized as a temperature change when the computed rate of a temperature change comes out on the ground from underground (step S3), an inverter 17 is ordered in control signal 21a corresponding to the optimal switching frequency (step S4) chosen by the control means 21.

[0009] Moreover, when the rate of a temperature change is over the set point (step S3), and a control means 21 takes out control signal 21a and reduces the switching frequency of an inverter 17, loss of a semiconductor device 18 is reduced. Even if it reduces a switching frequency, the rate of a temperature change is over the set point, and when it is more than the minimum value with a controllable switching frequency (step S5), an inverter 17 is ordered in control signal 21a to which a switching frequency is further reduced from a control means 21 (step S6). However, even if an inverter 17 becomes below the switching frequency of the minimum which can operate stably (step S5), when the rate of a temperature change is over the set point, the output of an inverter 17 is reduced and the temperature rise of a semiconductor device 18 is controlled (step S7). Furthermore, even if it reduces the output of an inverter 17, when the rate of a temperature change is over the set point, an inverter 17 is made to suspend an inverter 17 as what abnormalities generated (step S8). In addition, an inverter 17 may be stopped when an inverter 17 becomes below the switching frequency of the minimum which can operate stably (step S5).

[0010] As mentioned above, when the rate of a temperature change to the time amount of a semiconductor device 18 becomes beyond the set point, the miniaturization of a condensator can be attained by taking out control signal 21a from a control means 21, reducing the switching frequency of a semiconductor device 18, and controlling the temperature rise of a semiconductor device 18. Furthermore, when the rate of a temperature change to the time amount of a semiconductor device 18 becomes below the set point, for example from the ground like [at the time of going into the underground right of way], the noise of the inverter 17 at the time of transit can be reduced by raising the switching frequency of a semiconductor device 18 within limits which took out control signal 21a from the control means 21, and were decided from the volume of a condensator, the capacity of a condensator, etc. by the design stage.

[0011] Gestalt 2. drawing 3 of operation is the block diagram of the gestalt 2 of operation. In drawing 3 , 10-20 are the same as that of the thing of the gestalt 1 of operation. 22 is the control means as which temperature detecting-signal 20a is inputted, and when the rate of a temperature change is computed and the rate of a temperature change exceeds a failure decision value, it outputs stop signal 22a which stops an inverter 17. Furthermore, a control means 22 has a rate of a temperature change lower than a failure decision value, and when the set point set up like the gestalt 1 of operation is exceeded, it outputs control signal 22b to which the switching frequency of an inverter 17 is reduced. Next, actuation is explained. Drawing 4 is a flow chart explaining actuation of drawing 3 . It sets to drawing 3 and drawing 4 , and the usual power running and regeneration operation at the time of a brake are performed like the gestalt 1 of operation.

[0012] According to the right-of-way environment of the ground or underground, the inverter 17 is controlled by the optimal switching frequency (step S1). And a temperature sensor 20 detects temperature of a semiconductor device 18 (step S2), and temperature detecting-signal 20a is outputted. The control means 22 as which temperature detecting-signal 20a was inputted is t0. Rate of temperature change (T-T0)/(t-t0) to time amount is computed from the temperature C of T degrees of temperature T0-degreeC of the semiconductor device 18 in front of a second, and the semiconductor device 18 at present [t]. And when the rate of a temperature change is below the failure decision value (step S3) set as the value recognized as failure of a condensator (not shown) and is not over the set point further (step S4), an inverter 17 is ordered in control signal 22a corresponding to the optimal switching frequency (step S5) chosen by the control means 22. Moreover, although the rate of a temperature change is over the set point below with the failure decision value (step S3), when it is more than the minimum value with a controllable switching frequency (step S6), an inverter 17 is ordered in control signal 22a to which a switching frequency is reduced from a control means 22 (step S7).

[0013] However, even if an inverter 17 is stabilized and it becomes below the switching frequency of the minimum which can operate (step S6), when the rate of a temperature change is over the set point, the output of an inverter 17 is reduced and the temperature rise of a semiconductor device 18 is controlled (step S8). In addition, an inverter 17 may be stopped, when an inverter 17 is stabilized and it becomes below the switching frequency of the minimum which can operate (step S6). Furthermore, even if it reduces the output of an inverter 17, when the rate of a temperature change is over the set point, as what abnormalities generated in the inverter 17, a control means 22 takes out

stop signal 22b, and stops an inverter 17 (step S9). On the other hand, when the rate of a temperature change exceeds a failure decision value (step S3), as that to which the condensator (not shown) of a semiconductor device 18 broke down, a control means 22 takes out stop signal 22b, and stops an inverter 17 (step S9). In addition, failure of a condensator (not shown) can consider that refrigeration capacity declines according to causes, such as adhesion of dust and a liquid spill of a refrigerant. As mentioned above, when the temperature of a semiconductor device 18 rises rapidly like [at the time of failure of a condensator (not shown)] and the rate of a temperature change to the time amount of a semiconductor device 18 becomes beyond a failure decision value, Since switching operation is stopped before the temperature of a semiconductor device 18 rises to predetermined temperature by taking out stop signal 22b from a control means 22, and stopping the switching operation of a semiconductor device 18 Since it is not necessary to give remaining power to the refrigeration capacity of a condensator (not shown), the miniaturization of a condensator can be attained.

[0014]

[Effect of the Invention] According to this invention, when the rate of a temperature change to the time amount of a semiconductor device becomes beyond the set point, the miniaturization of a condensator can be attained by reducing the switching frequency of a semiconductor device and controlling the temperature rise of a semiconductor device. Moreover, when the rate of a temperature change to the time amount of a semiconductor device becomes below the set point, the noise of an inverter can be reduced by having raised the switching frequency of a semiconductor device, without increasing the capacity of a condensator. Furthermore, since switching operation is stopped before the temperature of a semiconductor device rises to predetermined temperature by stopping the switching operation of a semiconductor device when the rate of a temperature change to the time amount of a semiconductor device becomes beyond a failure decision value and it is not necessary to give remaining power to the refrigeration capacity of a condensator, the miniaturization of a condensator can be attained.

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CLAIMS

[Claim(s)]
[Claim 1] The control unit for electric rolling stock characterized by to have the control means to which the above-mentioned switching frequency of the above-mentioned semiconductor device reduces in the control unit for electric rolling stock which changes the direct current power of an electric car track into alternating current power with the inverter which consisted of semiconductor devices switched on a predetermined switching frequency, drives an AC motor, and sent out regeneration power to the above-mentioned electric car track through the above-mentioned AC motor at the time of a brake when the rate of a temperature change to the time amount of the above-mentioned semiconductor device becomes beyond the set point.
[Claim 2] The electric-rolling-stock control unit characterized by to have the control means to which the switching frequency of the above-mentioned semiconductor device makes increase in the control unit for electric rolling stock which changes the direct current power of an electric car track into alternating current power with the inverter which consisted of semiconductor devices switched on a predetermined switching frequency, drives an AC motor, and sent out regeneration power to the above-mentioned electric car track through the above-mentioned AC motor at the time of a brake when the rate of a temperature change to the time amount of the above-mentioned semiconductor device is below the set point.
[Claim 3] Change the direct current power of an electric car track into alternating current power with the inverter which consisted of semiconductor devices switched on a predetermined switching frequency, and`an AC motor is driven. As regeneration power is sent out to the above-mentioned electric car track through the above-mentioned AC motor at the time of a brake, it sets to the control unit for electric rolling stock. The control unit for electric rolling stock characterized by having the control means which stops the above-mentioned inverter when it becomes beyond the failure decision value with which the rate of a temperature change to the time amount of the above-mentioned semiconductor device is recognized to be failure of the condensator of a semiconductor device.

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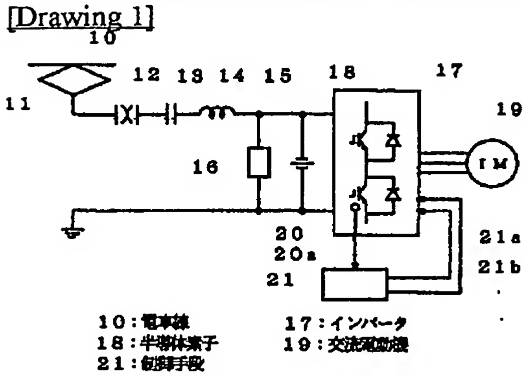
* NOTICES *

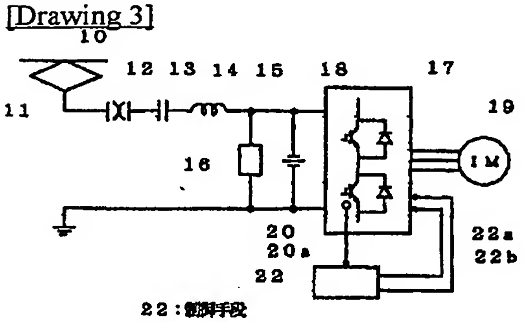
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

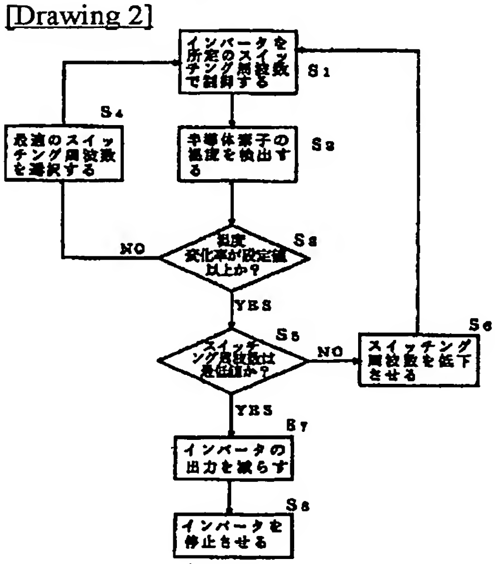
[Drawing 1]



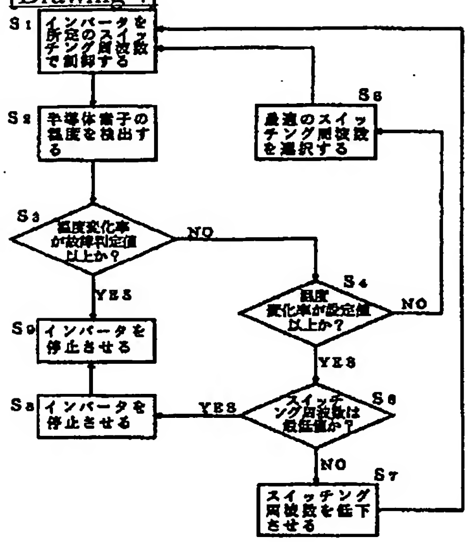
[Drawing 3]



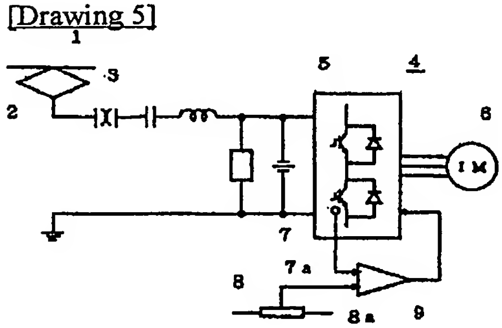
[Drawing 2]



[Drawing 4]



[Drawing 5]



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